



MX60 PV MPPT Charge Controller



QUICK & EASY GUIDE TO SETTING UP THE MX60 CHARGE CONTROLLER

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OVERVIEW

The MX60 Maximum Power Point Tracking (MPPT) charge controller enables the PV system to achieve its highest possible performance by periodically tracking the Maximum Power Point of the array. The MX60 can be used with battery systems from 12v to 60v DC with up to a 72v nominal PV array. The MX60 set points are fully adjustable to allow use with virtually any battery type, chemistry, and charging profile.

This user guide will demonstrate the **basic** operation and troubleshooting of your MX60 charge controller. This user guide does not cover the installation or additional feature programming of the MX60 charge controller. Please consult the Installation and User's Manual for more information.

MX60 WIRING COMPARTMENT

Figure 1 shows the wiring compartment of the MX60 charge controller.



Figure 1. MX60 charge controller wiring compartment

MX60 Wiring Components Defined:

4 Position Terminal Block

Main connection for the PV+, PV−, Bat−, and Bat +

MATE / HUB jack

MATE / HUB plug-in jack for remote monitoring of the MX60

Battery Temperature Sensor jack

Battery temperature sensor plug-in jack.

Aux Output Control

Programmable Auxiliary Output for load diversion, alarms, etc. **12v @ 0.2A**

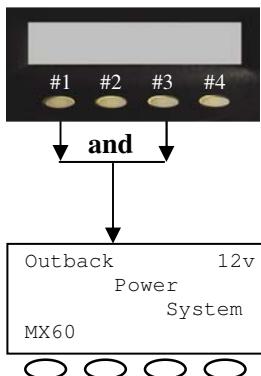
Ground lug

Aluminum ground lug for chassis/equipment ground

POWERING UP THE CHARGE CONTROLLER

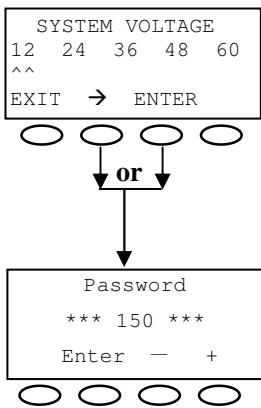
(This procedure is also used to reset the MX60 to factory default settings)

Begin by checking that the PV array and Battery wires are securely connected at the 4 Position Terminal Block of the MX60 charge controller.



Off/Blank screen

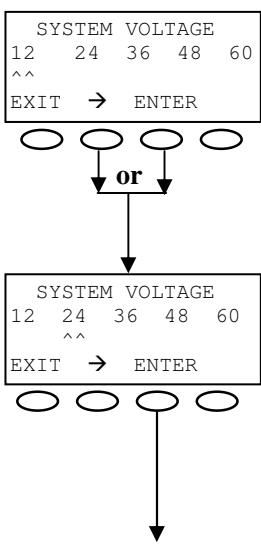
With the PV array **and** Battery breakers off, press and hold soft keys # 1 **and** # 3 simultaneously, then turn on the Battery breaker only.



Power-Up screen

Release **both** buttons when the Outback Power System Power-up screen is observed.

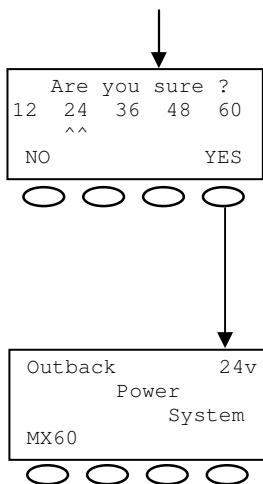
Proceed by pressing the “→” or “ENTER” soft key to select the desired nominal battery system voltage.



System Voltage screen

You will be prompted for a password to make changes to the system settings. The password is **141**. Proceed by pressing the “—” soft key until the numerical value is **141**. Press the “ENTER” soft key and the screen will be redirected to **System Voltage** screen again.

When the appropriate nominal battery voltage is selected press the “ENTER” soft-key.



Verification screen

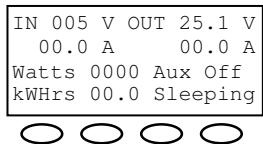
Confirm that the selected nominal battery voltage is correct by pressing the “YES” soft key. Note: If the incorrect nominal battery voltage is selected, repeat by starting at **Off/Blank** screen instead of pressing the “NO” soft key.

Power-Up screen

The MX60 will reboot to the **Power-Up** screen showing the selected nominal battery voltage at the upper-right corner.

STATUS SCREEN

Congratulations! You have successfully set up your MX60 charge controller for your nominal battery voltage.



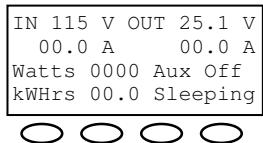
Status screen

This screen shows the numerical data of the input and output connected to the MX60 charge controller. Observe that the PV voltage (**IN**) is slowly rising even though the PV array breaker is off. This is normal!

The displayed information is defined as follows:

IN 005V = PV Input voltage	OUT 25.1V = Battery voltage
00.0A = Input PV current	00.0A = Output current (to battery)
Watts 0000 = Instantaneous watts	Aux Off = Programmable Auxiliary Output
kWhrs 00.0 = KiloWattHours accumulated	Sleeping = Operational Mode *

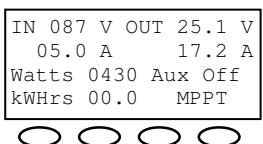
* Please reference pages 9 & 10 for more information on the various Operational Modes.



Preparing For Charging

Turn the PV array breaker on. The voltage will register at the upper-left of the display. The MX60 **automatically** detects the PV voltage -- no additional programming or setting is necessary to set the PV voltage.

Note: If PV voltage registers “000 V” when the PV breaker is on, please check polarity of PV array wires.



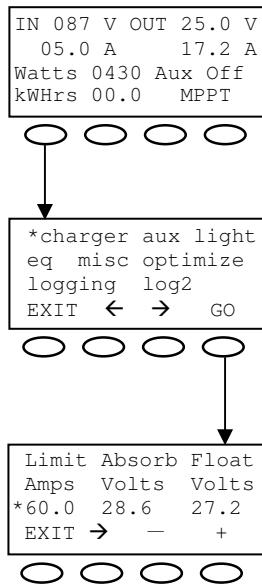
Preparing For Charging *continued....*

After ~ 5 seconds of stable PV input voltage the MX60 will “**Wakeup**” transition to “**Sweeping**” and prepare to charge the batteries by tracking the Maximum Power Point of the array (the most available power from the array). When the Maximum Power Point is “tracked” the MX60 will transition to the **BULK (MPPT)** state of charge.

BATTERY TEMPERATURE COMPENSATION VOLTAGE SET POINTS

The temperature of a battery has an impact on the charging process -- in higher ambient temperature conditions, the charger regulation set points (Absorb & Float) need to be reduced to prevent overcharging of the batteries. However, in lower ambient temperature conditions the charger regulation set points need to be increased to ensure complete recharging of the batteries.

The default charger settings of the MX60 are based on typical sealed lead acid battery systems. To change these setting simply follow the menu instructions below. *Always ensure that the Absorb & Float voltages are set to the recommended battery manufacturer's charging regulation set point voltages.*



Status screen

In the **Status screen** press soft key # 1 to enter the **Main Menu** screen.

Main Menu screen

In the **Main Menu screen**, position the asterisk at “charger”, then press “GO” to enter the “charger” menu screen.

Charger Menu Screen

In this menu screen the Current Limit (output current), Absorb, and Float set points can be adjusted as necessary. To make adjustments, move the asterisk to the desired parameter (Current, Absorb, Float) by pressing the “→” soft key. Pressing the “–” or the “+” soft keys will decrement or increment the desired parameter value. When the appropriate settings are made, press “EXIT” to return to the **Status screen**.

Note: Re-entry of password may be required.

SUGGESTED BATTERY CHARGER SET POINTS

The battery manufacturer should provide you with specific instructions on the following maintenance and charging regulation set point limits for the specific batteries. The following information can be used when the manufacturer's information is not available. Note: Higher settings can be used with non-sealed batteries, but water consumption will be greater and excessive temperatures when charging may occur

SEALED LEAD ACID – AGM / GEL

	12v	24v	48v
ABSORB voltage set point	14.3v	28.6v	57.2v
FLOAT voltage set point	13.6v	27.2v	54.4v

NON-SEALED LEAD ACID

	12v	24v	48v
ABSORB voltage set point	14.8v	29.6v	59.2v
FLOAT voltage set point	13.6v	27.2v	54.4v

Non-Battery Temperature Compensated System

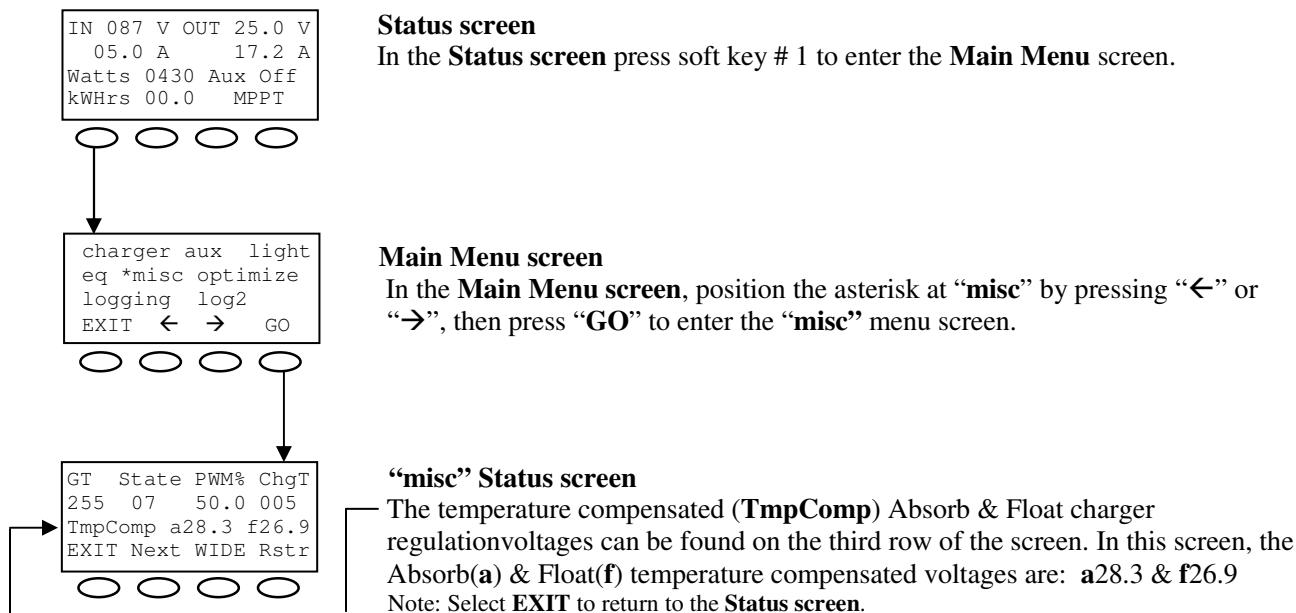
If a battery temperature sensor is not available the Absorb and Float voltage set points can be adjusted for the expected weather conditions. The following table shows the appropriate adjustments for both Absorb and Float voltage set points for weather conditions above or below 77°F / 25°C.

EXPECTED TEMPERATURE	ADJUST SETPOINT	12v	24v	48v
Average = 95°F / 35°C	Subtract	0.30v	0.60v	1.20v
Average = 86°F / 30°C	Subtract	0.15v	0.30v	0.60v
<hr/>				
Average = 68°F / 20°C	Add	0.15v	0.30v	0.60v
Average = 59°F / 15°C	Add	0.30v	0.60v	1.20v

Battery Temperature Compensated System

A battery temperature sensor will automatically compensate the Absorb and Float voltage relative to the Absorb and Float charger regulation set points in the “charger” menu. Always ensure that the Absorb and Float voltage are set to the recommended battery manufacturer’s set points.

Menu Map of where to view the battery temperature compensated Absorb and Float voltages

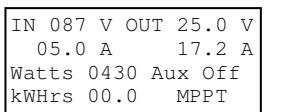


Note: It is recommended that the Outback Battery Temperature Sensor be installed in the **Master** of the FX/VFX/GTFX/GVFX series inverter, MX60 and HUB installation.

GRID-TIE APPLICATION with GTFX SERIES INVERTERS

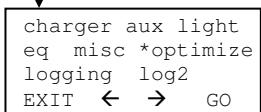
The MX60 charge controller has a grid-tie (FX-GT) mode that allows the GTFX/GVFX series inverter to manage the Absorb and Float charger regulation set points of the MX60 charge controller. The FX-GT mode is **only** applicable with GTFX/GVFX series inverter **and** HUB installation.

Menu Map of where to set FX-GT mode



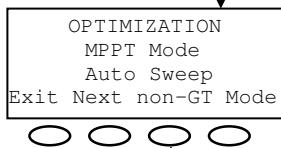
Status screen

In the **Status screen** press soft key # 1 to enter the **Main Menu** screen.



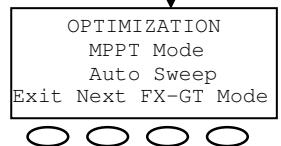
Main Menu screen

In the **Main Menu screen**, position the asterisk at “**optimize**” by pressing “←” or “→”, then press “**GO**” to enter the “**optimize**” menu screen.



Optimization Screen

In the **Optimization screen**, scroll through the menus by pressing “**NEXT**” until the MPPT Mode menu is observed. Press soft key # 3 to change from **non-GT** to **FX-GT** mode. Note: Re-entry of password may be required.

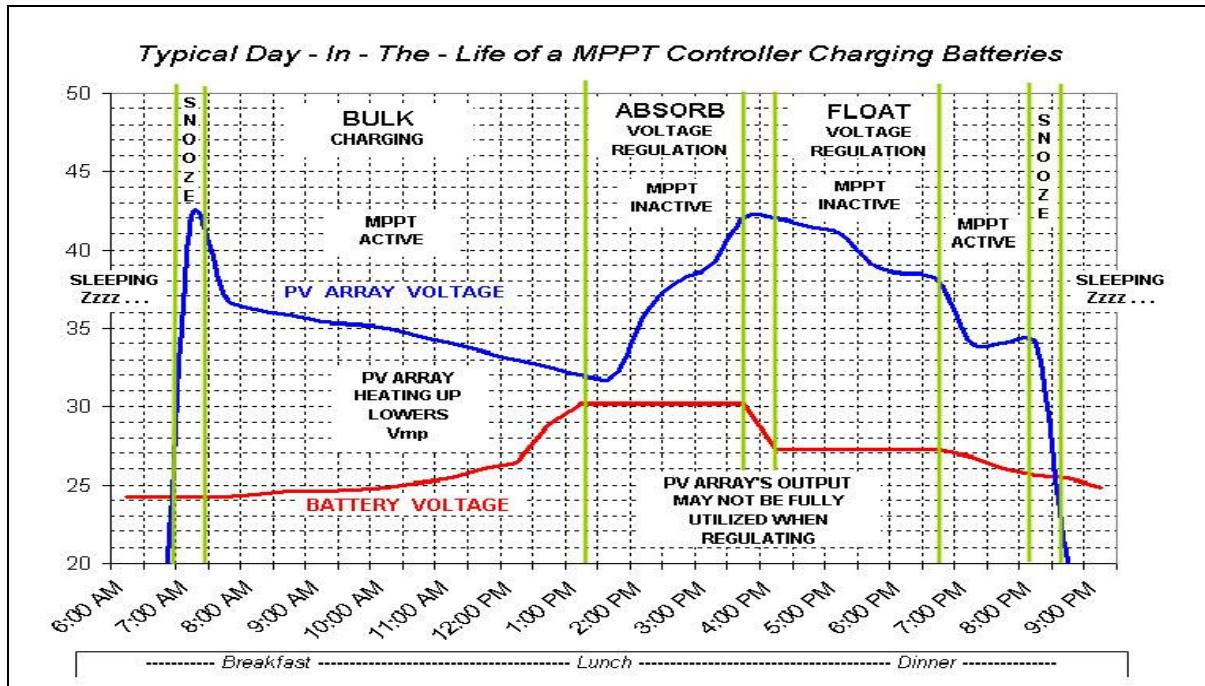


Optimization Screen *continued*

With the **FX-GT** mode selected press “**EXIT**” to return to the **Status screen**.

MULTI-STAGE BATTERY CHARGING

The MX60 charge controller is a sophisticated multi-stage battery charger that uses several regulation stages to allow fast recharging of the battery system while ensuring a long battery life. This process can be used with both sealed and non-sealed batteries. The MX60 will automatically set the charging regulation voltage set points (Absorb & Float) for the selected nominal battery voltage, however, always follow the battery manufacturer's recommended charging regulation voltages. The MX60 charging regulation stages correspond to the chart below.



BULK This stage provides the maximum power to the battery -- voltage increases while charging

A Bulk charge is automatically initiated when the battery voltage is below the Absorb and Float voltage set points. The Bulk charge will continue until the Absorb voltage set point is achieved.

ABSORBING This stage limits the amount of power going to the battery -- the voltage is held constant

The Absorb charge will continue for the duration of the Bulk cycle or until the 2 hour (default) Absorb time limit is reached. Example, if a Bulk charge takes 1 hour to reach the Absorb voltage set point then the Absorb charge will continue for 1 hour as well. However, if a Bulk charge takes 3 hours to reach the Absorb voltage set point then the Absorb charge will last for 2 hours only. A Bulk charge will be re-initiated if the battery voltage is not sustained at the Absorb voltage set point.

FLOAT This stage reduces the charging voltage to prevent overcharging of the batteries

A Float charge follows after the Absorb charge is completed. The MX60 will not re-initiate another Bulk charge if the Float voltage set point is not sustained, however, it will continue to charge the battery until the Float voltage set point is achieved. Note: A Bulk charge can be initiated if the battery voltage falls below the Float voltage set point if the re-Bulk (ReBV) voltage option is set.

UNDERSTANDING THE VARIOUS OPERATIONAL MODES

The modes of operation will change occasionally during the day based on PV array output and battery system state of charge. The MX60 operating modes are displayed at the bottom right hand corner of the Status screen.

Sleeping PV voltage is less than battery voltage or charger current is below the minimum cutoff (Lowcutoff) current. This may also appear briefly during the day when the MX60 is transitioning between certain states, and because of other conditions.

Zzzz... At night (3 hours of Sleeping) the MX60 will display **Zzzz...** until the next wakeup. At the next wakeup, (usually the next morning), the daily statistics, (AmpHours, KWh, etc.), will accumulate into the total statistics and then the displayed daily statistics will clear.

Wakeup As the PV open circuit voltage, (Voc), rises above the battery system voltage by ~2 volts, the MX60 prepares to deliver power to the batteries. During this period, the MX60 is calculating the PWM duty cycles, turning on power supply voltages in the proper sequences, and making internal calibrations. At wakeup, the MX60 closes its relays and will then start sweeping the input voltage, (the “initial” sweep), towards the battery voltage. At dawn and dusk this may happen many times until there is (or is not) enough power from the PV array to keep going. Wakeup is also a time when the MX60 acquires a new Voc.

Sweeping In Auto-Sweep MPPT mode, the MX60 is either doing an initial sweep of the panel voltage from Voc towards battery voltage after wakeup, or is doing a periodic dithering mini-sweep to stay on the max power point. Below 5 amps of battery output current, this will flash briefly as the MX60 operates at the **Park Mpp** voltage. This message may also appear briefly if the MX60 has reached the max battery current setting and is raising the PV operating voltage to keep the battery current from exceeding the maximum battery output current limit setting.

MPPT The MX60 is in Maximum Power Point Tracking mode and is trying to get the battery voltage to reach the Absorb or Float voltage set point in the Bulk or Float charge stages. If the MX60 is in the Bulk charge stage, the Charge Timer (ChgT), will count up to the max Absorb time.

Absorbing The MX60 is in the Absorb (constant voltage) charge stage, keeping the battery voltage at the Absorb voltage set point, (modified by battery temperature compensation if installed), and the ChgT counter in the miscellaneous screen is counting down towards zero from however long the MX60 was in Bulk. If the system cannot keep the battery voltage at the Absorb voltage set point, then the MX60 will return to the Bulk charge stage, display MPPT, and the ChgT counter will start counting up again towards the MAX Absorb time set point.

Absorb There is an external DC source (wind generator/hydro) keeping the battery at or above the Absorb set point.

Bat Full The MX60 is waiting for the battery voltage to fall to just below the Float voltage set point before continuing with the Float stage. This may also be displayed when external DC charging sources are present.

Float The MX60 is in the Float charge stage and is keeping the battery at the Float voltage set point. If the system cannot keep up with the Float voltage set point, (e.g. DC loads are on), then the MX60 will return to MPPTing, display MPPT, and try it's best at again reaching the Float set point target voltage.

New Voc The MX60 is acquiring a new open circuit panel voltage periodically in the U-Pick MPPT mode.

Re-Cal There are certain abnormal conditions that can confuse the current measuring method in the MX60. When and if this happens, the MX will temporarily stop and re-calibrate. This may sometimes happen because of negative current, i.e., current coming out of the input terminals instead of into the input terminals, or a tripped PV breaker. A new Voc is also acquired during a Re-Cal.

Bat Tmp Err The battery temperature sensor is shorted or damaged.

EQ MPPT The equalization process has been manually started and the MX60 is seeking the Equalization voltage set point (EQ is **NOT** battery temperature compensated). The AUX output will be disabled in all but the Manual On mode. After the EQ voltage has been reached, EQ 0:00 will be displayed and the EQ time in hours and minutes will be displayed. The DC loads should be turned off and the battery should be charged enough so that the MX60 can reach the EQ voltage set point, otherwise the MX60 cannot start the EQ cycle.

EQ 0:00 This message shows that the EQ cycle has started and shows how long it has progressed in Hours:minutes.

EQ DONE Once the set EQ time, (1 to 7 hours), has successfully completed, EQ DONE will be displayed either until a button is pressed, or the next morning's wakeup.

Low Light / Snoozing During the initial sweep, (see Wakeup and Sweeping), if it is determined that it is too late (or too early), in the day, the MX60 will display Low Light for a few seconds, then display Snoozing for 5 minutes, which is a form of sleeping. This is meant to reduce energy and unnecessary powering of the MX. This can, of course, be displayed in extremely cloudy weather. The snoozing mode can be disabled and has 2 basic modes to choose from. One mode is based on the speed of the ability of the PV to charge the input capacitors and another mode looks at the initial wakeup sweep current to see if it reached the low cutoff (default) current set point.

Unloaded The battery terminals were abruptly unloaded. May be displayed if the battery breaker trips while MPPTing or the system voltage is set too low.

AutoStart (Auto Re-Start) Once every 3 hours, in MPPT mode, and once every 4 hours, in the Absorb and Float charge modes, the MX60 will start over from sleep and re-sweep (full sweep) and re-calibrate the current sensor. This can either be disabled completely, selected to only Auto Re-Start in MPPT mode, or Re-Start in MPPT and Absorb/Float charge mode. It is recommended that this mode be left to mode 2, Auto Re-Start in all 3-charger modes. (See LOG2 screen)

MXTooHot (Very rare) Either the MX60 is just too hot or its internal temperature sensor is shorted. If you do get this message, check (very carefully) to see if the MX60 is really hot on the outside heatsink. The heat generated by the MX60, and therefore its losses, are proportional to input voltage times output current. It is also a good idea NOT to install the MX60 in direct sunlight.

SysError (Very rare) System Error indicates an internal non-volatile memory error. The unit will stop operating when this message is displayed. Call the factory if you see this message.

PV COLD This indicates that the PV array's open circuit voltage is too high for the controller to safely operate. This should only occur with systems using 72v DC nominal PV arrays in very cold temperatures (below 5 °F / -15 °C). The controller will automatically restart operation once the PV array's open circuit voltage falls to a safe level (135v). The amount of time required for it to reset is dependant on the module type, ambient temperature, and the amount of sunlight directly on the PV array. Normally, the controller will start-up in the morning within a few minutes of the PV array being in direct sunlight. Reconfiguring the PV array for a 48v DC nominal will eliminate this from occurring.

Troubleshooting Guide

MX60 does not boot/power-up (blank screen)

1. Check battery connection and polarity
Reverse polarity or improper connection will cause power-up issues.
2. Is the battery voltage greater than 10.5v? (Measure the battery-side of 4 Position Terminal block)
A battery voltage less than 10.5v may not power up the MX60
3. If the MX60 still does not power up, call the factory for additional support
- .

MX60 is always SLEEPING

1. Is battery voltage greater than the Absorb voltage set point (compensated Absorb voltage)?
If yes, the MX60 will not wake up since the battery voltage is at/above the Absorb target voltage set point
2. Is the PV voltage greater than the battery voltage by at least 2 volts?
The PV voltage has to be at least 2 volts greater than the battery voltage for the initial wakeup.
3. Check the PV array breaker (or fuse)
Ensure that the PV array breaker (or fuse) is sized appropriately.
5. Does the PV array voltage on the display rise with the PV breaker OFF, but reads 000 with the PV breaker on?
If so, the PV array polarity connection on the MX60 maybe reversed or the PV wires could be shorted.
6. Check the short circuit current of the PV array?
Use a multimeter to determine if a short circuit current is detected. The short circuit current test will not harm the array.

MX60 not producing expected power

1. Is it cloudy and/or is there shading on the panels?
Clouds, partial shading (or dirty panels) can cause poor performance symptoms.
2. What is the current limit set to?
A lower current limit set point (“**charger**” menu) will yield a loss of power or poor performance symptoms
3. Are the batteries charged? Is the MX60 in the Absorbing or Float stage?
If so, the MX60 will produce enough power to regulate the voltage at the Absorb or Float set point voltage, therefore, requiring less power in *these* modes.
4. What is the short circuit current of the PV array?
Use a multimeter to determine if a short circuit current is as expected. There might be a loose/faulty PV array connection.
5. Is the PV array voltage close to the battery voltage?
If so, the panels could be warm/hot causing the Maximum Power Point of the array to be at or lower than the battery voltage.
Please reference APPENDIX F –TYPICAL ARRAY SIZING GUIDE in the Installation and User’s Manual for more information.

MX60 Sweeping frequently

1. What is the current limit set point?

When the current limit set point is achieved the MX60 will continue sweeping to maintain the targeted current limit

2. What is the sweep interval set point?

A short sweep interval time will cause the MX60 to sweep frequently. A sweep interval of 7 to 10 minutes is recommended

MX60 Battery Temperature Compensated Voltage

1. Can I use a Battery Temperature Sensor (BTS/RTS) other than the OutBack BTS/RTS?

No.

2. Why is the battery voltage above/below the Absorb and Float voltage set points?

The battery voltage can rise above the Absorb and Float voltage set points if the battery temperature is $< 77^{\circ}\text{F}$ or fall below the Absorb and Float voltage if the battery temperature is $> 77^{\circ}\text{F}$.

3. Why does the MX60 show “**BatTmpErr**” on the **Status** screen?

The BTS is faulty/damaged. Disconnect the BTS from the BTS jack to resume normal operation.

MX60 Internal Fan

1. Should the internal fan be running when the MX60 is producing power?

The internal fan will only run when the internal temperature has reached $\sim 115^{\circ}\text{F}$.

2. How long does the internal fan run?

The internal fan will run as needed. In the MISC menu, the fan will run, if and only if, the value of PCB is lower than the value **350**. *Please reference the User’s Manual for more information.*